REMARKS

In view of the following remarks responsive to the non-final Office Action of October 10, 2003, the Applicant respectfully requests favorable consideration of this Application.

The Patent and Trademark Office (Office) has objected to the proposed drawings as not being properly cross-hatched. In response, the Applicant has submitted corrected drawings, labeled Figures 1–5, reflecting cross-hatching as required by 37 C.F.R. §1.84(h)(3).

The Office has rejected all pending claims, i.e. claims 1-20 and 24-29. Specifically, the Office has rejected claims 1, 6, 7, 9, 10, 12, 13, 16-18, and 24-29 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,431,328 (Chang, et al.). Claims 2-5, 11, 14, 15, 19, and 20 have also been rejected by the Office under 35 U.S.C. § 103(a) as being unpatentable over Chang in view of U.S. Patent No. 6,337,445 (Abbott, et al.).

The Present Invention

The present invention relates generally to flip chip bonding of semiconductors. More particularly, the invention introduces a new type of solder ball for use in flip chip type bonding. The solder ball comprises a substantially non-deformable dielectric core, a solderable metal layer completely surrounding the core, and a solder layer completely surrounding the metal layer. The dielectric core has a higher melting temperature than the solderable metal layer.

During the process of interconnecting two substrates in accordance with the present invention, the solder balls are placed on a pick up tool, such as a vacuum pick up tool, and are dipped in flux. The pick up tool is then positioned over the first substrate and lowered to place the solder balls in contact with the solder pads of the first substrate. The pick up tool is removed, leaving the solder balls on the solder

pads. The first substrate is then heated to reflow the solder layer of the solder balls so that the solder balls become affixed to the solder pads of the first substrate. The second substrate is then positioned over the first substrate and lowered so as to bring the solder pads of the second substrate in contact with the solder balls. The entire assembly is then heated again to reflow the solder layer of the solder balls and, optionally, solder on the solder pads of the second substrate causing the two substrates to become mechanically and electrically connected through the solder balls.

The Chang Reference

Chang discloses a method for composite bump flip chip bonding that utilizes a composite bump core which is partially covered by a metal coating layer and by a solder layer. Chang explicitly states that this composite bump (32) (Figure 1) is comprised of a polymer body "with a low Young's Modulus relative to that of metals and a conductive metal coating covering the polymer body." (Chang, col. 2, lines 15-18). Young's Modulus, also known as the Elasticity Modulus, of a material is the ratio of the stress versus the strain within the elastic region of the material's stress-strain diagram. A high Young's modulus indicates that the material is rigid while a low Young's modulus indicates that the material is elastic. Since the composite bump core described by Chang comprises a material with a low Young's Modulus, the core is deformable. According to Chang, "[d]ue to the low Young's Modulus of the polymer body [core,] the stress tending to break the solder joint during or after the soldering process is extremely small." (Chang, col. 5, lines 23-26). In fact, Chang clearly states that this composite bump core is deformed during the formation of the bonded structure. (Chang, Abstract).

Applicant's R sponse to the Rej ctions

Applicant respectfully traverses the Office's rejections for the following reasons:

First, with respect to the § 102(b) anticipation rejection, the Office has failed to show that Chang teaches every element of the rejected claims.

Second, with respect to the § 103(a) obviousness rejection, the Office has failed to establish a *prima facie* case of obviousness as required by MPEP § 2143.03 (particularly, the references, when combined, must teach all of the claim limitations) with respect to the disclosures of Chang in view of Abbott.

A. Chang Fail to Teach Every Element of the Rejected Claims.

The Office has rejected claims 1, 6, 7, 9, 10, 12, 13, 16-18, and 24-29 under 35 U.S.C. § 102(b) as being anticipated by Chang.

For a claim to be anticipated under §102(b), the cited reference must teach every element of that claim. (MPEP § 2131). The Federal Circuit has held that "[a] claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

In the present invention, the Applicant claims a solder-coated article comprising "a substantially **non-deformable** dielectric core ..." (Claim 1). That is, the Applicant has claimed a core whose shape is substantially non-alterable by physical pressure or stress. As noted at page 5, lines 21-22 of the Specification, the preferred dielectric materials for the core include ceramic materials, such as alumina and sapphire, and glass materials, such as alkali-silicates, alumina silicates, etc. These materials are rigid and difficult to bend and, therefore, have a relatively high Young's Modulus. As a comparative reference, Table 1 highlights the Young's Modulus of various materials.

TABLE 1

Material	Young's Modulus (GPa)
Beeswax	0.2
PTFE (Teflon)	0.5
Polycarbonate polymer	2.4
Pine wood (along grain)	10.0
Aluminum metal	70.0
* Fused silica glass	75.0
* Aluminosilicate	89.0
Titanium metal	107.0
Brass alloy	110.0
Stainless steel 304	207.0
Silicon nitride	290.0
* Alumina (Al_2O_3)	370.0
* Sapphire	400.0
Diamond	1140.0

Note that a deformable polymer such as that taught by Chang has a modulus in the area of 2.4, whereas the non-deformable core of the present invention, including materials such as silica glass, aluminosilicate, alumina, and sapphire, have moduli of 75.0, 89.0, 370.0, and 400.0, respectively. Clearly, the dielectric core of the present invention is not anticipated by Chang because Chang does not teach a core comprised of a non-deformable material. For at least this reason, Applicant respectfully requests that the Office withdraw its rejection.

B. The Combination of Chang and Abbott Fails to Establish a *Prima Facie* Case of Obviousness

The Office has rejected claims 2-5, 11, 14, 15, 19, and 20 under 35 U.S.C. § 103(a) as being unpatentable over Chang in view of Abbott.

The Office has the initial burden of establishing a *prima facie* case of obviousness. MPEP § 2142. To establish a *prima facie* case of obviousness, the combined references cited by the Office must meet three criteria: (a) the references

must teach all of the claim limitations; (b) there must be some suggestion or motivation to modify the reference teachings to encompass the claimed invention; and (c) there must be a reasonable expectation of success. MPEP § 2143. With respect to the first criteria, the Office must demonstrate that all of the claim limitations are taught or suggested by the prior art. MPEP § 2143.03 (citing *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974)).

The Office attempts to make the case that it would have been obvious to one skilled in the art to combine the teachings of Chang and Abbott to arrive at the claimed invention. To support this argument, the Office begins with the proposition that Chang teaches "a substantially non-deformable dielectric core". (Office Action of October 10, 2003, p. 2). As described above, Chang does not teach a non-deformable core. In fact, Chang actually teaches the opposite – that is, a deformable core.

Moreover, neither Chang nor Abbott teach a solderable metal layer "**completely surrounding**" the core. In Chang, the core (32) directly attaches to the circuit element pads (26) leaving the conductive metal coating (36) to cover only a portion of the core. Abbott's solder ball does not include solder, only a core and two metal layers. As can be seen in Abbott's Figures 6A, 6B, 7, 8, and 11A, the solder ball itself (prior to being used to interconnect two circuit elements) has no solder at all. In Abbott, the solder is applied to the solder pads on the circuit elements, whereas, in the present invention, the solder is the outer layer of the inventive solder ball itself. As stated in the specification, one of the key advantages of the present invention is a reduction in the number of processing steps to interconnect two substrates. Specifically, the entire interconnection is provided in the solder ball itself and it merely needs to be placed on the first substrate and heated and then placed in contact with the second substrate and heated. Abbott still requires the separate, additional steps involved in depositing the solder on the bond pads of the two circuit elements. The present invention eliminates

these steps by providing a single pre-manufactured article that includes the core, the solderable metal layer, and the solder.

Based upon the teachings of Chang and Abbott, the Office's argument is ineffectual because these references, when combined, clearly do not teach or suggest all of the claim limitations required to support a rejection under §103(a). For at least this reason, Applicant respectfully requests that the Office withdraw its rejection.

Conclusion

The Office has not established that Applicant's independent claims (Claims 1, 9, 16, and 24-26) are anticipated by or obvious over the cited references. Furthermore, if an independent claim is not anticipated under 35 U.S.C. § 102(b) and is nonobvious under 35 U.S.C. § 103, then any claim depending therefrom is also not anticipate and is nonobvious. MPEP § 2143.03 (citing *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)). Thus, each of Applicant's claims is in condition for allowance.

In view of the foregoing remarks, Applicant respectfully requests that the Office issue a Notice of Allowance at the earliest possible date. The Office is invited to contact Applicant's undersigned counsel by telephone call in order to further the prosecution of this case in any way.

Respectfully submitted,

Dated: Jan. 6, 2004

Jimmie Johnson
Registration No. 52,485
Synnestvedt & Lechner
2600 Aramark Tower
1101 Market Street
Philadelphia, PA 19107
Telephone: (215) 923-4466
Facsimile: (215) 923-2189